Please amend claims 1, 3-12, 14-15, 18, and 21 as indicated below.

1. (Currently Amended) A method for implementing bump mapping, comprising:

generating a table of color values for a geometry of a polygon in view of a light source and a viewing direction of the polygon, the table of color values to be referenced by orientation-dependent color variables;

determining vertex angle coordinates for a plurality of vertex vectors of the polygon, including a normal vector (N), a light source vector (L), and a halfway vector between the light source vector (H) and a viewing direction of the polygon (V);

interpolating the vertex angle coordinates with vertex values of the vertices of the polygon to provide angle coordinates for each pixel in the polygon, the angle coordinates representing a direction of the vertex vector at the pixel;

modifying the angle coordinates using a perturbation source to generate perturbed angle coordinates;

converting the perturbed angle coordinates to one or more color variables; and

assigning the pixel a color value from the table of color values referenced by the one or more color variables,

wherein table of color variables includes a first color variable (u_c) and a second color variable (v_c), wherein the first and second color variables are defined as:

$$u_c = \begin{cases} .5 - \alpha/\pi & if\ (\mathbf{N} \bullet \mathbf{L}_2) \geq 0 \\ .5 + \alpha/\pi & if\ (\mathbf{N} \bullet \mathbf{L}_2) < 0 \end{cases} \quad and \quad v_c = \begin{cases} \beta/\pi & if\ (\mathbf{N} \bullet \mathbf{L}) \geq 0 \\ 1 - \beta/\pi & if\ (\mathbf{N} \bullet \mathbf{L}) < 0 \end{cases},$$

where L2 is a basis vector of a Cartesian coordinate system for L, wherein α represents an angle between N and a projection of N (S1) onto a plane represented by L and L2, and wherein β represents an angle between S1 and another basis vector of the Cartesian coordinate system (L1).

2. (Previously Presented) The method of claim 1, wherein modifying the angle coordinates includes:

    generating angle perturbations based on bump coordinates of each vertex of the polygon;

        and

    combining the angle perturbations with the angle coordinates to generate the perturbed

        angle coordinates.

3. (Currently Amended) The method of claim ~~2, wherein generating angle perturbations comprises:~~

    ~~estimating the bump coordinates for the pixel; and~~

    ~~converting the bump coordinates to angle perturbations.~~1, wherein the table of color

        variables is represented via a color map (C) defined as follows:

$$C(u_C, v_C) = M_a L_a + M_d L_d \Omega_L(u_C, v_C) + M_s L_s \Omega_H(u_C, v_C)^A,$$

    wherein M_a, Md, and Ms represent characteristics of object material for ambient light,

        diffuse, and specular respectively, wherein Ω_L and Ω_H are predetermined functions

        for L and H respectively based on u_c and v_c, and A represents a specular exponent.

4. (Currently Amended) The method of claim 3, wherein ~~converting the bump coordinates comprises retrieving angle perturbations from a bump map location referenced by the bump coordinates,~~ if L and V are substantially in parallel, Ω_L and Ω_H are defined substantially identical defined as follows:

    $\Omega(u_c, v_c) = \cos[\pi(.5 + u_c)] \sin[2\pi v_c] = \sin[\pi u_c)] \sin[2\pi v_c].$

5. (Currently Amended) The method of claim ~~1~~4, wherein ~~the plurality of vertex vectors includes at least one of a normal vector, a light source vector, and a halfway vector between the light~~

~~source vector and a viewing direction of the polygon.~~ if L and V are not substantially in parallel, Ω_H is defined as follows:

$\Omega_H(u_c, v_c) = \sin[\pi(u_c - u_{cH})] \sin[2\pi(v_c - v_{cH})]$.

6. (Currently Amended) The method of claim 3, wherein ~~estimating the bump coordinates comprises:~~

~~determining bump coordinates for vertices of the polygon;~~

~~interpolating bump coordinates for the pixel from the determined vertex bump~~

~~coordinates.~~ if multiple lights are used to illuminating the polygon, the color map is defined as follows:

$$C^1[u_c, v_c] = \sum_{j=0}^{N-1}\left(M_{aj} L_{aj} + M_{dj} L_{dj}\left(N_x[u_c, v_c]\bullet L_j\right) + M_{sj} L_{sj}\left(N_x[u_c, v_c]\bullet H_j\right)^A\right)$$

and

$$C^2[u_c, v_c] = \sum_{j=0}^{N-1}\left(M_{aj} L_{aj} + M_{dj} L_{dj}\left(N_y[u_c, v_c]\bullet L_j\right) + M_{sj} L_{sj}\left(N_y[u_c, v_c]\bullet H_j\right)^A\right),$$

wherein $N_x[u_c, v_c]$ and $N_y[u_c, v_c]$ are a set of vectors that sample a range of orientations with respect V. $N_x[u_c, v_c]$ and $N_y[u_c, v_c]$ are defined as follows:

$$N_x[u_c, v_c] = \begin{pmatrix} x_u \\ y_v \\ \sqrt{1 - x_u^2 - y_v^2} \end{pmatrix} \quad if\ (x_u^2 + y_v^2) < 1$$

$$N_x[u_c, v_c] = \cfrac{\left(\begin{array}{c} \cfrac{x_u}{\sqrt{x_u^2 + y_v^2}} \\[2ex] \cfrac{y_v}{\sqrt{x_u^2 + y_v^2}} \\[2ex] 0 \end{array} \right) \ otherwise}{\rule{9cm}{0.4pt}}, \ \underline{\text{and}}$$

$$N_y[u_c v_c] = \left(\begin{array}{c} x_u \\ -y_v \\ \sqrt{1 - x_u^2 - y_{vi}^2} \\ 0 \end{array} \right) \ if \ (x_u^2 + y_v^2) < 1$$

$$\rule{9cm}{0.4pt}$$

$$N_y[u_c v_c] = \left(\begin{array}{c} \cfrac{x_u}{\sqrt{x_u^2 + y_v^2}} \\[2ex] \cfrac{y_v}{\sqrt{x_u^2 + y_v^2}} \\[2ex] 0 \end{array} \right) \ otherwise$$

$$\rule{9cm}{0.4pt}$$

$\underline{\therefore}$

7. (Currently Amended) A graphics system comprising:

    a geometry engine to associate vector orientation data with vertices of one or more polygons representing an object in an image;

    a color map including color values for a sample of vector orientations, each color value to be referenced by one or more orientation dependent color variables;

    a perturbation source to provide orientation perturbations; and

a rendering engine to

generate a table of color values for a geometry of a polygon in view of a light

source and a viewing direction of the polygon, the table of color values to

be referenced by orientation-dependent color variables,

determine vertex angle coordinates for a plurality of vertex vectors of the polygon,

including a normal vector (N), a light source vector (L), and a halfway

vector between the light source vector (H) and a viewing direction of the

polygon (V),

interpolate the vertex angle coordinates with vertex values of the vertices of the

polygon to provide angle coordinates for each pixel in the polygon, the

angle coordinates representing a direction of the vertex vector at the pixel,

modify the angle coordinates using a perturbation source to generate perturbed

angle coordinates,

convert the perturbed angle coordinates to one or more color variables, and

assign the pixel a color value from the table of color values referenced by the one

or more color variables,

wherein table of color variables includes a first color variable (u_c) and a second

color variable (v_c), wherein the first and second color variables are defined

as:

$$u_c = \begin{cases} .5 - \alpha/\pi \ if \ (\mathbf{N} \bullet \mathbf{L}_2) \geq 0 \\ .5 + \alpha/\pi \ if \ (\mathbf{N} \bullet \mathbf{L}_2) < 0 \end{cases} \text{ and } v_c = \begin{cases} \beta/\pi & if \ (\mathbf{N} \bullet \mathbf{L}) \geq 0 \\ 1 - \beta/\pi \ if \ (\mathbf{N} \bullet \mathbf{L}) < 0 \end{cases},$$

where L2 is a basis vector of a Cartesian coordinate system for L, wherein α

represents an angle between N and a projection of N (S1) onto a plane

represented by L and L2, and wherein β represents an angle between S1

and another basis vector of the Cartesian coordinate system (L1).

8. (Currently Amended) The graphics system of claim 7, <u>wherein the table of color variables is</u>

<u>represented via a color map (C) defined as follows:</u>

$$C\left(u_c, v_c\right) = M_a L_a + M_d L_d \Omega_L\left(u_c, v_c\right) + M_s L_s \Omega_H\left(u_c, v_c\right)^A,$$

<u>wherein M_a, Md, and Ms represent characteristics of object material for ambient light,</u>

<u>diffuse, and specular respectively, wherein Ω_L and Ω_H are predetermined functions</u>

<u>for L and H respectively based on u_c and v_c, and A represents a specular</u>

<u>exponent</u><s>wherein the orientation-dependent color variables are linearly related to</s>

<s>angle coordinates that specify the sampled vector orientations.</s>

9. (Currently Amended) The graphics system of claim <s>7</s><u>8</u>, wherein <u>if L and V are substantially in</u>

<u>parallel, Ω_L and Ω_H are defined substantially identical defined as follows:</u>

<u>$\Omega(u_c, v_c) = \cos[\pi(.5 + u_c)] \sin[2\pi v_c] = \sin[\pi u_c)] \sin[2\pi v_c]$</u><s>the perturbation source is a bump map</s>

<s>including angle perturbations referenced by the perturbation coordinates.</s>

10. (Currently Amended) The graphics system of claim 9, wherein <u>if L and V are not</u>

<u>substantially in parallel, Ω_H is defined as follows:</u>

<u>$\Omega_H(u_c, v_c) = \sin[\pi(u_c - u_{cH})] \sin[2\pi(v_c - v_{cH})]$</u><s>the rendering engine includes a generator that</s>

<s>combines the angle coordinates and angle perturbations into perturbed color coordinates.</s>

11. (Currently Amended) The graphics system of claim <s>7</s><u>8</u>, wherein <u>if multiple lights are used to</u>

<u>illuminating the polygon, the color map is defined as follows:</u>

$$C^1\left[u_c, v_c\right] = \sum_{j=0}^{N-1}\left(M_{aj} L_{aj} + M_{dj} L_{dj}\left(\mathbf{N_x}\left[u_c, v_c\right] \bullet \mathbf{L_j}\right) + M_{sj} L_{sj}\left(\mathbf{N_x}\left[u_c, v_c\right] \bullet \mathbf{H_j}\right)^A\right)$$

<u>and</u>

$$C^2\left[u_c, v_c\right] = \sum_{j=0}^{N-1}\left(M_{aj} L_{aj} + M_{dj} L_{dj}\left(\mathbf{N_y}\left[u_c, v_c\right] \bullet \mathbf{L_j}\right) + M_{sj} L_{sj}\left(\mathbf{N_y}\left[u_c, v_c\right] \bullet \mathbf{H_j}\right)^A\right),$$

wherein $N_x[u_c,v_c]$ and $N_y[u_c,v_c]$ are a set of vectors that sample a range of orientations with respect **V**. $N_x[u_c,v_c]$ and $N_y[u_c,v_c]$ are defined as follows:

$$N_{\mathbf{x}}[u_c,v_c] = \begin{pmatrix} x_u \\ y_v \\ \sqrt{1-x_u^2-y_v^2} \end{pmatrix} \; if \; (x_u^2+y_v^2) < 1$$

$$N_x[u_c,v_c] = \begin{pmatrix} \dfrac{x_u}{\sqrt{x_u^2+y_v^2}} \\ \dfrac{y_v}{\sqrt{x_u^2+y_v^2}} \\ 0 \end{pmatrix} \; otherwise$$

, and

$$N_{\mathbf{y}}[u_c v_c] = \begin{pmatrix} x_u \\ -y_v \\ \sqrt{1-x_u^2-y_{vi}^2} \\ 0 \end{pmatrix} \; if \; (x_u^2+y_v^2) < 1$$

$$N_{\mathbf{y}}[u_c v_c] = \begin{pmatrix} \dfrac{x_u}{\sqrt{x_u^2+y_v^2}} \\ \dfrac{y_v}{\sqrt{x_u^2+y_v^2}} \\ 0 \end{pmatrix} \; otherwise \; \sout{the perturbation source is an algorithm for associating}$$

$\sout{perturbations with polygon locations according to a property of the image.}$

12. (Currently Amended) A machine readable medium on which are stored instructions that are executable by a system to implement a method for assigning a color value to an image pixel, the method comprising:

generating a table of color values for a geometry of a polygon in view of a light source and a viewing direction of the polygon, the table of color values to be referenced by orientation-dependent color variables,

determining vertex angle coordinates for a plurality of vertex vectors of the polygon, including a normal vector (N), a light source vector (L), and a halfway vector between the light source vector (H) and a viewing direction of the polygon (V),

interpolating the vertex angle coordinates with vertex values of the vertices of the polygon to provide angle coordinates for each pixel in the polygon, the angle coordinates representing a direction of the vertex vector at the pixel,

modifying the angle coordinates using a perturbation source to generate perturbed angle coordinates,

converting the perturbed angle coordinates to one or more color variables, and

assigning the pixel a color value from the table of color values referenced by the one or more color variables,

wherein table of color variables includes a first color variable (u_c) and a second color variable (v_c), wherein the first and second color variables are defined as:

$$u_c = \begin{cases} .5 - \alpha / \pi \ if \ (\mathbf{N} \bullet \mathbf{L}_2) \geq 0 \\ .5 + \alpha / \pi \ if \ (\mathbf{N} \bullet \mathbf{L}_2) < 0 \end{cases} \quad and \quad v_c = \begin{cases} \beta / \pi \quad if \ (\mathbf{N} \bullet \mathbf{L}) \geq 0 \\ 1 - \beta / \pi \ if \ (\mathbf{N} \bullet \mathbf{L}) < 0 \end{cases},$$

where L2 is a basis vector of a Cartesian coordinate system for L, wherein α represents an angle between N and a projection of N (S1) onto a plane represented by L and L2, and wherein β represents an angle between S1 and another basis vector of the Cartesian coordinate system (L1).

13. (Previously Presented) The machine readable medium of claim 12, wherein modifying angle coordinates comprises:

generating the angle perturbations for the pixel; and

combining the angle perturbations with the angle coordinates to form perturbed angle coordinates.

14. (Currently Amended) The machine readable storage medium of claim 12, wherein the table of color variables is represented via a color map (C) defined as follows:

$$C(u_c, v_c) = M_a L_a + M_d L_d \Omega_L(u_c, v_c) + M_s L_s \Omega_H(u_c, v_c)^A$$

wherein M_a, M_d, and M_s represent characteristics of object material for ambient light, diffuse, and specular respectively, wherein Ω_L and Ω_H are predetermined functions for L and H respectively based on u_c and v_c, and A represents a specular exponent~~12, wherein the plurality of vertex vectors includes at least one of a normal vector, a light source vector, and a halfway vector between the light source vector and a viewing direction of the polygon.~~

15. (Currently Amended) A graphics system comprising:

means for associating a plurality of vertex angles with each vertex of one or more polygons representing an object in an image;

means for indicating color values for a sample of vector orientations, each color value to be referenced by one or more orientation dependent color variables;

means for providing orientation perturbations; and

means for converting the plurality of vertex angles for each polygon to a plurality of angle coordinates and perturbation coordinates for each pixel in the polygon, including a normal vector (N), a light source vector (L), and a halfway vector between the light source vector (H) and a viewing direction of the polygon (V); and

means for combining the angle and perturbation coordinates to generate a perturbed color

variable and to provide at least one of the color values for each pixel with the

perturbed color variable,

wherein the color variables include a first color variable (u_c) and a second color variable

(v_c), wherein the first and second color variables are defined as:

$$u_c = \begin{cases} .5 - \alpha / \pi \; if \; (\mathbf{N} \bullet \mathbf{L}_2) \geq 0 \\ .5 + \alpha / \pi \; if \; (\mathbf{N} \bullet \mathbf{L}_2) < 0 \end{cases} \text{ and } v_c = \begin{cases} \beta / \pi \quad if \; (\mathbf{N} \bullet \mathbf{L}) \geq 0 \\ 1 - \beta / \pi \; if \; (\mathbf{N} \bullet \mathbf{L}) < 0 \end{cases}$$

where L2 is a basis vector of a Cartesian coordinate system for L, wherein α represents an

angle between N and a projection of N (S1) onto a plane represented by L and L2,

and wherein β represents an angle between S1 and another basis vector of the

Cartesian coordinate system (L1).

16. (Original) The graphics system of claim 15, wherein the providing means is a bump map
including angle perturbations referenced by the perturbation coordinates.

17. (Original) The graphics system of claim 16, wherein the combining means includes a
generator that combines the angle coordinates and angle perturbations into perturbed color
coordinates

18. (Currently Amended) A system comprising:

a graphics pipeline; and

a memory, in which are stored instructions that are executable by the graphics pipeline to

implement a method for assigning a color value to a pixel, the method

comprising:

generating color values for a sample of vector orientations, each color value being

associated with first and second angle coordinates representing a

corresponding vector orientation;

determining a pair of vertex angle coordinates for each vertex vector of a polygon that includes the pixel, including a normal vector (N), a light source vector (L), and a halfway vector between the light source vector (H) and a viewing direction of the polygon (V);

interpolating the pairs of vertex angle coordinates to provide first and second angle coordinates for the pixel;

perturbing the first and second angle coordinates to provide modified first and second angle coordinates; and

retrieving a color value for the pixel according to the perturbed first and second angle coordinates,

wherein the color variables include a first color variable (u_c) and a second color variable (v_c), wherein the first and second color variables are defined as:

$$u_c = \begin{cases} .5 - \alpha / \pi \ if \ (\mathbf{N} \bullet \mathbf{L}_2) \geq 0 \\ .5 + \alpha / \pi \ if \ (\mathbf{N} \bullet \mathbf{L}_2) < 0 \end{cases} \quad and \quad v_c = \begin{cases} \beta / \pi \quad\ if \ (\mathbf{N} \bullet \mathbf{L}) \geq 0 \\ 1 - \beta / \pi \ if \ (\mathbf{N} \bullet \mathbf{L}) < 0 \end{cases},$$

where L2 is a basis vector of a Cartesian coordinate system for L, wherein α represents an angle between N and a projection of N (S1) onto a plane represented by L and L2, and wherein β represents an angle between S1 and another basis vector of the Cartesian coordinate system (L1).

19. (Original) The system of claim 18, wherein each color value is associated with first and second angle coordinates through one or more angle coordinates that index the color value.

20. (Original) The system of claim 18, wherein the graphics pipeline includes texture mapping hardware and the color values are accessed using the texture mapping hardware.

21. (Currently Amended) A computer implemented method comprising:

generating a plurality of color values for a sample of vector orientations in view of a light source and a viewing direction of a polygon that includes a pixel, the plurality of color values being stored in a color table referenced by one or more color variables;

determining a pair of angle coordinates for the pixel from a set of one or more vertex vectors of the polygon including at least one of a normal vector (N), a light source vector (L), and a halfway vector (H) between the light source vector and the viewing direction (V) of the polygon;

interpolating the pair of angle coordinates with vertex values associated with the vertices of the polygon;

modifying the interpolated pair of angle coordinates with a perturbation value;

determining a color variable with the modified interpolated pair of angle coordinates;

assigning at least one of the plurality of color values to the pixel from the color table referenced by the color variable,

wherein the color variables include a first color variable (u_c) and a second color variable (v_c), wherein the first and second color variables are defined as:

$$u_c = \begin{cases} .5 - \alpha / \pi \; if \; (\mathbf{N} \bullet \mathbf{L}_2) \geq 0 \\ .5 + \alpha / \pi \; if \; (\mathbf{N} \bullet \mathbf{L}_2) < 0 \end{cases} \quad and \quad v_c = \begin{cases} \beta / \pi \quad if \; (\mathbf{N} \bullet \mathbf{L}) \geq 0 \\ 1 - \beta / \pi \; if \; (\mathbf{N} \bullet \mathbf{L}) < 0 \end{cases}$$

where L2 is a basis vector of a Cartesian coordinate system for L, wherein α represents an angle between N and a projection of N (S1) onto a plane represented by L and L2, and wherein β represents an angle between S1 and another basis vector of the Cartesian coordinate system (L1).